ADVANCED DYNAMICS OF STRUCTURES / Home Work 2 / October 15, 2007	ADVANCED DYNAMICS OF STRUCTURES / Home Work 2/ October 15, 2007
Consider the system of three degrees-of-freedom shown:	Consider the system of three degrees-of-freedom shown:
a. Write down the equations of motion of the system by including the ground motion $v_g(t)$	a. Write down the equations of motion of the system by including the ground motion
and the external load $p_i(t)$ and evaluate the mass matrix <b>m</b> , the rigidity matrix <b>k</b> , and	$v_g(t)$ and the external load $p_i(t)$ and evaluate the mass matrix <b>m</b> , the rigidity matrix
the flexibility matrix $\mathbf{k} = \mathbf{d}^{-1}$ .	<b>k</b> , and the flexibility matrix $\mathbf{k} = \mathbf{d}^{-1}$ .
b. Determine the three circular frequencies and the periods of the free vibration $\omega_i$ and $T_i$	b. Determine the three circular frequencies and the periods of the free vibration $\omega_i$ and $T_i$
and the corresponding mode shapes $\mathbf{\varphi}$ . Give their graphical representation $(i = 1, 2, 3)$ ,	and the corresponding mode shapes $\boldsymbol{\varphi}$ . Give their graphical representation $(i = I, 2, 3)$ ,
c. Check the orthogonality of the modes with respect to the mass matrix and the stiffness	c. Check the orthogonality of the modes with respect to the mass matrix and the stiffness
matrix $\mathbf{\varphi}^{-T}\mathbf{m}  \mathbf{\varphi}_2,  \mathbf{\varphi}^{-T}\mathbf{m}  \mathbf{\varphi}_3$ and $\mathbf{\varphi}^{-T}\mathbf{k}  \mathbf{\varphi}_2,  \mathbf{\varphi}^{-T}\mathbf{k}  \mathbf{\varphi}_3$ .	matrix $\mathbf{\varphi}_i^{-T} \mathbf{m}  \mathbf{\varphi}_2$ , $\mathbf{\varphi}_i^{-T} \mathbf{m}  \mathbf{\varphi}_3$ and $\mathbf{\varphi}_i^{-1} \mathbf{k}  \mathbf{\varphi}_3$ .
d. Evaluate the generalized masses and stiffness $M_i = \mathbf{\varphi}^{-T}\mathbf{m}  \mathbf{\varphi}_i$ and $K_i = \mathbf{\varphi}^{-T}\mathbf{k}  \mathbf{\varphi}_i$ , and assess	d. Evaluate the generalized masses and stiffness $M_i = \mathbf{\varphi}_i^{-T} \mathbf{m}  \mathbf{\varphi}_i$ and $K_i = \mathbf{\varphi}_i^{-T} \mathbf{k}  \mathbf{\varphi}_i$ , and assess
$\omega_i^{-2} = K_i / M_i$ .	$\omega_i^{-2} = K_i / M_i$ .
e. Obtain the first free vibration mode shapes $\mathbf{\varphi}_i$ and the corresponding the first circular	e. Obtain the first free v ibration mode shapes $\mathbf{\varphi}_i$ and the corresponding the first circular
frequencies $\omega_i$ of the system by using Stodola method,	frequencies $\omega_i$ of the system by using Stodola method,
f. The heights of the stories are $h = 3$ meter, the columns of the first story have cross section	f. The heights of the stories are $h = 3$ meter, the columns of the first story have cross
of $0.30m \times 0.50m$ , the first period of the system is $T_i = 0.25s$ and $E = 30GPa$ . Find the	section of $0.30m \times 0.50m$ , the first period of the system is $T_i = 0.25s$ and $E = 30GPa$ .
numerical values of the stiffness $k$ , the mass $m$ , the parameter $mg/k$ , the second $T_2$ and the	Find the numerical values of the stiffness $k$ , the mass $m$ , the parameter $mg/k$ , the second
third $T_2$ period of the system.	$T_2$ and the third $T_3$ period of the system.
ProfDr Hasan Boduroğlu	ProfDr Hasan Boduroğlu
ProfDr Zekai Celep / http://www.ins.itu.edu.tr/zcelep/zc.htm	ProfDr Zekai Ce lep / http://www.ins.itu.edu.tr/zce lep/zc.htm
$M_i \qquad \int_{Kat kallesi} m^2 \int_{V_i} \frac{P_i}{R_i} \int_{R_i} \frac{P_i}{R_i} \int_{$	$M_i = \frac{R_{ijk} plate}{K_{at} deleme rightig 3k}$ , $\frac{P_i}{K_{at} deleme rightig 3k}$ , $\frac{P_i}{K_{at} deleme rightig 3k}$ , $\frac{P_i}{K_{at} deleme rightig 4k}$ , $\frac{P_i}{K_{at}}$ , $\frac{P_i}{K_$